Chapter I

Introduction

It has been over thirty-years since the Bureau of Land Management (BLM) completed its intensive inventory of roadless areas of 5,000 acres or more in Elko District to determine if they possessed characteristics of wilderness. Upon inventory and study using key factors from the Wilderness Act of 1964, if it was determined that these roadless 5,000 acre areas appeared natural and provided an outstanding opportunity for solitude or an outstanding opportunity for primitive and unconfined recreation then the land possessed wilderness characteristics (BLM, 1978). The BLM compiled a list of areas considered to have wilderness characteristics and presented them to the Secretary of the Interior, who in turn reported to the President areas recommended for designation as wilderness. The President then makes recommendations to Congress for designation as wilderness or to deny such action by legislation (BLM, 2001). However, until Congress makes a decision that the land with wilderness characteristics will be a designated as wilderness or released from consideration the BLM must manage these areas in such a way as to not impair their suitability for wilderness designation (BLM, 1978). While under review by Congress designated Wilderness Study Areas (WSAs) are managed to provide minimal impact to the WSA Unit.

As part of the initial and intensive inventories the roads, ways, and cherry stems (referred to from here as routes) were mapped in relation to their respective WSA. In all cases routes present were inventoried and measured for inclusion in BLM's Geographic Information System (GIS) database and for inclusion on WSA maps to show legal motor vehicle travel routes and boundary roads. However, no criteria or data on the physical condition of the routes; such as soil erosion, soil compaction, and soil displacement was gathered and/or recorded for each route in the WSAs. For the purposes of this study it is assumed that during the thirty years that the WSAs have been managed as *de facto* wilderness areas changes have occurred on the ground in relation to routes, vegetation, and wildlife.

Since 2002, WSAs have come under the management of the National Landscape Conservation System (NLCS) within the Bureau of Land Management. The "mission for the NLCS is to conserve, protect, and restore nationally significant landscapes and places that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations" (BLM, 2011, p. 1). Congressionally designated Wilderness Study Areas that have been managed under the protection of the BLM for the past thirty-years offer an outstanding opportunity for NLCS to gather data and develop methods for accessing route conditions and changes that have occurred to the routes in the WSAs over-time.

Purpose of the Study

The purpose of this project was to gain a better understanding of current route conditions and identify potential impacts from off-highway vehicle (OHV) use on the soil and vegetation in six WSAs that are located in the Tuscarora Field Office (TFO) in Elko, Nevada.   To date route studies have focused on the impacts of OHVs on wildlife, erosion, hydrology, scenery, vegetation, riparian areas, and noise, (Sampson, 2009); however, more information is needed on the impacts of OHV routes on natural recovery and vegetation disturbance response in arid and semi-arid ecosystems (Wilshire, 1977; Sampson). To enable future comparisons of present route conditions and changes that occur to the routes over time baseline data is needed on WSA routes managed by Tuscarora Field Office. This study investigated and gathered baseline route data in six WSAs in TFO to determine if routes are left dormant, to what extent do these previously established routes recover on their own or do they continue to deteriorate.

Study questions are:

1. What is the current soil and vegetation condition of previously identified OHV routes in TFO's six Wilderness Study Areas?
2. What is the current soil and vegetation condition of new trespass routes and/or previously undocumented OHV routes in TFO's six Wilderness Study Areas?
3. To what extent if any have the route's characteristics changed since being documented in the initial intensive inventory of TFO's six Wilderness Study Areas?

Benefits

Anecdotal evidence indicates that since the initial inventory over 30-years ago was conducted some of the routes associated with WSAs have revegetated to the point of disappearing from the landscape on WSAs in the Tuscarora FO. This seems contrary to studies conducted to this point in arid and semi-arid ecosystems that find some areas never recover from OHV travel or may take a century or more to mend through natural forces (Webb & Wilshire, 1980; Wilshire et al., 1978). Negative impacts of OHV routes on wildlife, riparian areas, artifacts, scenery, soils, and others are well studied (Brooks & Lair, 2005; Lei, 2004; Luckenbuch & Bury, 1983). Studies have also examined active management to restore OHV roads, but natural recovery of vegetation, wildlife, scenery, and riparian areas following road closures has received less attention (Brooks & Lair, 2005; Duffield et al., 2002). In a time of fiscal restraint of limited funding and manpower, it is critical to the NLCS to determine the conditions that promote natural route recovery to prioritize management actions in WSAs.

It is assumed that if the roads vanish and return to a new ecological state then wildlife would return, riparian areas would clear from erosion sediment, and the natural scenery would abound within the WSAs and maybe even lands adjacent to them. From a management point of view it would be of benefit to understand the timeframe that damage to the soil takes to recover in differing ecosystems (Rosentreter et al., 2003). Currently the BLM is updating their lands with wilderness characteristics inventories per the Federal Land Policy and Management Act of 1976 (FLPMA) and travel management as a requirement of new resource management plans being developed for Elko District Office. Having some idea of the length of time that it takes an area's routes to recover by natural means compared to mechanical reclamation will provide information for decision makers. For example, deciding which existing roads to maintain into remote areas when developing plans for dispersed recreation or motorcycle racing events taking place on BLM lands or limiting and closing multiple duplicate roads that cross rangelands to end at the same point it will be another piece of data to use in managing for resource conservation.

Definition of Terms

The following definitions are provided to ensure uniformity and understanding of these terms throughout the study:

Cherry Stems. "Dead-end roads (i.e., "cherry stem roads") may extend into the unit and are excluded from the unit, which will modify the unit boundary" (BLM, 2012, p. 10).

Off Highway Vehicles (Off-Road Vehicle). Defined by the BLM, 2001 as:

> Any motorized vehicle capable of, or designed for, travel on or immediately over land, water, or other natural terrain, excluding: (1) Any nonamphibious registered motorboat; (2) Any military, fire, emergency, or law enforcement vehicle while being used for emergency purposes; (3) Any vehicle whose use is expressly authorized by the authorized officer, or otherwise officially approved; (4)

> Vehicles in official use; and (5) Any combat or combat support vehicle when used in times of national defense emergencies. (p. 24)

Road. The BLM 2012 states:

> For the purpose of inventorying wilderness characteristics only, the BLM will continue to base the "road" definition on FLPMA's legislative history. The language below is from the House of Representatives Committee Report 94-1163, page 17, dated May 15, 1976, on what became FLPMA. The word 'roadless' refers to the absence of roads that have been improved and maintained by mechanical means to insure relatively regular and continuous use. A way maintained solely by the passage of vehicles does not constitute a road. The BLM will refer to routes that meet the above definition as wilderness inventory roads. The BLM previously adopted and will continue to use sub-definitions of certain words and phrases in the BLM wilderness inventory road definition stated above. Routes that have been improved and maintained by mechanical means to insure relatively regular and continuous use are wilderness inventory roads. a. Improved and maintained – Actions taken physically by people to keep the road open to vehicle traffic. "Improved" does not necessarily mean formal construction. "Maintained" does not necessarily mean annual maintenance.
>
> b. Mechanical means – Use of hand or power machinery or tools.
>
> c. Relatively regular and continuous use – Vehicular use that has occurred and will continue to occur on a relatively regular basis. Examples are: access roads for equipment to maintain a stock water tank or other established water sources; access roads to maintained recreation sites or facilities; or access roads to mining claims.

A route that was established or has been maintained solely by the passage of vehicles would not be considered a road for the purposes of wilderness inventory, even if it is used on a relatively regular and continuous basis. Vehicle routes constructed by mechanical means but that are no longer being maintained by mechanical methods are not wilderness inventory roads. Sole use of hands and feet to move rocks or dirt without the use of tools or machinery does not meet the definition of “mechanical means.” Wilderness inventory roads need not be “maintained” on a regular basis but rather “maintained” when road conditions warrant actions to keep it in a usable condition. A dead-end (cherry-stem) road can form the boundary of an inventory area and does not by itself disqualify an area from being considered “roadless.”

A route, or a segment of a route, which was mechanically improved to permit the passage of vehicles, but which to date has not needed any further mechanical improvement or maintenance to facilitate the relatively regular and continuous passage of vehicles, can be a road in those circumstances where the road would be maintained if the need were to arise.

While the purpose of a route is not a deciding factor to consider in determining whether a route is a road for wilderness inventory purposes, it does provide context in which to consider the criteria for a road determination. For example, the purpose of the route provides context when the BLM considers whether maintenance of the route insures relatively regular and continuous use and whether maintenance, that may so far have been unnecessary to insure the use, would occur when the need arises. (p. 11-12).

Route: "Roads, primitive roads, and trails that are part of the transportation system" (BLM, 2012, p. 12).

Soil Compaction. "The air spaces between soil particles are squeezed out by the pressure of vehicles, but the soil isn't transported to any new location. . . This is soil displacement not soil erosion" (Wilshire, 2000, p. 10)

Soil Erosion. "That soil is transported away from its place of origin, by water, wind, or gravity" (Wilshire, 2000, p. 10).

Ways. "The word 'roadless' refers to the absence of roads that have been improved and maintained by mechanical means to insure relatively regular and continuous use. A way maintained solely by the passage of vehicles does not constitute a road" (BLM, 2012, p. 11).

Wilderness. As defined in section 2(c) of the Wilderness Act of 1964:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an

unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Wilderness Characteristic. As defined in BLM 2012:

> These attributes include the area's size, its apparent naturalness, and outstanding opportunities for solitude or a primitive and unconfined type of recreation. They may also include supplemental values. Lands with wilderness characteristics are those lands that have been inventoried and determined by the BLM to contain wilderness characteristics as defined in section 2(c) of the Wilderness Act. (p. 12)

Assumptions

For this study it is assumed that since the routes were identified in intensive inventories thirty-three years ago that some of the routes would have disappeared without any prescribed reclamation of the routes. It was also assumed that trespass routes have been established in WSAs since the closing of the WSAs to travel by existing routes.

Another assumption is that the research interns would gather and record route data following protocol using the same method on every route and record data truthfully, and that they had an adequate knowledge of the Trimble GEO-XM Global Positioning System (GPS) units and CITRIX to enter data correctly. The rationale for assuming interns used the same protocol and methods in recording data truthfully are that the interns were trained in the methods and this form of team training has been used successfully in the past.

Instruction and demonstration of measuring techniques and use of the instrumentation was given to the research interns that data would be gathered similarly throughout the study by the research interns. It was also assumed that the research interns would feel comfortable working in remote areas far from the office. Another assumption of the current study was that sample points along the routes were representative of the entire route.

Limitations

The purposive sampling procedure decreases the generalizability of the findings. Because this study focuses on routes in six WSAs in Tuscarora Field Office it may not be generalizable to routes in other WSAs in Elko District or other NLCS units. This was not a longitudinal study, so it is not possible to formulate firm conclusions regarding the empirical findings of the route's characteristics having changed since being documented in the initial intensive inventory of Wilderness Study Areas.

A non-probability sampling technique is used because it would have been impossible or near impossible to get exact route measurements or to tell in advance of driving the boundaries of the WSAs where the trespass routes entered into the WSA. However, each of the route data points where track depth measurements were recorded were selected at random from a random starting point with at least four data points recorded along a route. Even on maps built in Citrix that showed routes in the WSAs they were not necessarily the same as found on the ground. So, a method of taking a data point based on the best estimate from data found in CITRIX was used and for the trespass routes there was no way of knowing that they existed before finding them and then it was a guess as to their length so data points were distributed along the route in a manor to at least capture four data points as equally distributed as possible along its length.

For future OHV route research in other WSAs a pre-inventory to get exact lengths of the existing routes and locations of trespasses could be completed before the survey starts as part of wilderness monitoring. Having the route length data in CITRIX or a GIS system would allow the known length to be divided in a manner so that a random sample could be drawn from the route length and entered into the GPS as a data point. For the purposes of this study being generalizable to other WSAs in NLCS was not the main issue but to identify current conditions of routes and vegetation in Tuscarora Field Office, as it relates to trespasses or the disappearance of previously identified ways in WSAs.

Delimitations

Routes in this study are delimited to Wilderness Study Areas which (a) were identified in the initial intensive inventory of 1979, (b) in the Tuscarora Field Office, or (c) were found to be a trespass route since the original intensive inventory 33 years ago.

Chapter II

Literature Review

Policy and Guidance

It has been nearly 50 years since the Wilderness Act of 1964 was passed into law. With passage of the Wilderness Act the National Wilderness Preservation System (NWPS) was created adding 54 new areas, totaling 9.1 million acres of land to the system. Since then the NWPS has grown to 757 areas totaling 109, 512,959 acres of land in 44 states and Puerto Rico (Wilderness.net). In 2009, President Obama signed the Omnibus Public Land Management Act, and Sec. 2002, established the National Landscape Conservation System within the Bureau of Land Management: "In order to conserve, protect, and restore nationally significant landscapes that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations, there is established in the Bureau of Land Management the National Landscape Conservation System" (p. 269). The NCLS includes areas with designations of: national monuments, national conservation areas, and wilderness study areas that are administered by the BLM. The NLCS currently manages over 27 million acres of land, rivers, and trails in 887 different units (BLM, 2011).

Passage of the Federal Land Policy and Management Act, BLM's "organic act," put the responsibility of inventory, identification, and administration of public lands, per FLPMA Sec. 201, and Bureau of Land Management Wilderness Study Sec. 603, in FLPMA of public lands on the BLM. Following FLPMA in 1978, the BLM developed the Wilderness Inventory Handbook to provide guidance on the wilderness inventory process (BLM, 1978) as described in FLPMA and the Wilderness Act. In developing the handbook four major issues of significance were identified during the public review period with defining a road receiving the most comments.

Because of the strongly stated opposition to the definition of a "road" in the original draft the handbook now uses the definition found in the legislative history of FLPMA to conduct lands with wilderness characteristics inventories.

The *Wilderness Inventory Handbook* contained the steps taken to identify areas with wilderness characteristics as part of the initial wilderness review process in 1979. The BLM was responsible for conducting the inventory, completing a study, and reporting the results to Congress with recommendations for suitability or non-suitability for wilderness designation. For interim management Congress (BLM, 1995; 1978):

> Requires that the BLM will manage lands which meet the criteria in the law for identification as Wilderness Study Areas in such a way, and in accordance with the law, as not to impair their suitability for Wilderness designation by Congress until Congress designates such areas as Wilderness or denies wilderness designation for such areas by legislative action. (p. 3)

Updated guidance for management of WSAs can be found in BLM Manual 6330-*Management of Wilderness Study Areas* that replaces BLM Handbook 8550-1, *Interim Management Policy for Lands Under Wilderness Review*.

Impacts of Roads and Ways

Use of the term "inventoried roadless areas" came about in the 1970s when the USDA Forest Service conducted Roadless Area and Evaluations (RARE I & RARE II) in carrying out the Wilderness Act, and used "roads" in forming the boundaries of "roadless lands" at least 5,000 acres in size. Based upon the USDA Forest Service's "roadless areas" in 1980, the BLM delivered to the President a list of all the roadless areas of 5,000 acres or more for consideration for wilderness review. In Elko County Nevada, ten WSAs totaling 272,422 acres were sent forward and are currently under wilderness review. Four of the WSAs are in the Wells Field Office and six are in the Tuscarora Field Office. Within each of these WSAs are ways and cherry stem roads that form boundaries that protrude and go into the WSAs and each was identified as part of the original intensive inventory in 1980.

Over the past 33 years tracks made from vehicle trespass have been found entering into WSAs thereby creating unauthorized routes into the WSAs and potentially impacting the land, flora, and fauna. Although OHVs and their uses for racing, wildlife viewing, and touring into remote places, for hunting, fishing, and camping purposes are valid recreation uses, research indicates that these uses can have serious effects upon desert soils, vegetation, wildlife, scenery, archeological sites, riparian areas, and other values (Duffield et al., 2002; Sampson, 2009; Wilshire, 1977; Wilshire et al., 1978). According to Wilshire (1977) "by the time FLPMA was enacted, off-road vehicles were predominate among the threats to the integrity of natural and cultural resources of the desert" . . . . (p. 489)

For the BLM management of sediments from erosion resulting from OHV routes is one of the most pervasive impacts on native aquatic communities and listed fish species (Duffield et al., 2002). As stated by Sampson "the most important long-term effect of OHV use on public lands is the accelerated erosion and attendant ability to support natural re-vegetation" (2009, p. 190). Sampson also finds that "off-highway vehicle use produces a profound effect upon vegetation, and rehabilitation efforts often are marginally successful or unsuccessful" (p. 190). Some of the adverse effects on wildlife include the loss of cover, loss of potential food, excessive noise, frightening wildlife enough to abandon their habitats and death (Sampson). "Arid lands simply cannot sustain vehicular recreation for an appreciable period of time, in particular when it is loosely regulated and not well maintained" (Sampson, p. 197).

Description of Known Road Effects

Erosion of soils in arid lands is caused by vehicles compacting/displacing and modifying the natural surface which in most cases strips the surface of vegetation and in doing so increases the erosion power of runoff in volume and velocity (Sack & da Luz., 2003; Wilshire, 1977; Webb et al., 1978). Wilshire states that "hundreds of measurements have shown that typical motorcycles driven in a straight line on a dry surface will impact one acre of land in about 20 miles, and a typical 4-wheel vehicle does the same in about 6 miles" (1977, p. i). What this means in terms of road effects as Duffield et al., (2002) state:

> (a) roads contribute more sediment to streams than any other land management activity; (b) roads directly affect natural sediment and hydrologic regimes by altering stream flow, sediment loading, sediment transport and deposition, channel morphology, channel stability, substrate composition, stream temperature, water quality, and riparian conditions within a watershed. These habitat alterations can adversely affect all life-stages of fish, including migration, spawning, incubation, emergence, and rearing; (c) roads greatly increase the frequency of landslides, debris flows, and other mass movements and; (d) road/stream crossing can be a major source of sediment to streams resulting from channel fill around culverts and subsequent road crossing failures.

No systematic approaches to predicting assessing, monitoring, mitigating or minimizing impacts from linear disturbances are used in arid and semi-arid ecosystems where higher rates of OHV use are occurring (Dunaway & Herrick, 2011). Wilshire finds that studies of soil compaction in desert town sites abandoned for as long as 70 years show that soil does not recover for about a century or more if erosion occurs (1983).

Today, in Elko County and other western states human land use patterns are characterized by expanding populations into rural and exurban areas with the increasing "human footprint," within western ecosystems this results in an increasing suite of anthropogenic features such as roads, power lines, and other infrastructure necessary to maintain these human populations (Brooks et al., 2003; Leu et al., 2008).

Chapter III

Methodology

The purpose of this study was to (a) gather data on the current soil and vegetation condition of previously identified OHV routes in TFO's six Wilderness Study Areas, (b) to document the extent if any that the route's characteristics changed since being documented in the initial intensive inventory of Wilderness Study Areas, and (c) to gather and document the current soil and vegetation condition of trespass routes and/or previously undocumented OHV routes in TFO's six Wilderness Study Areas.

To accomplish this comparison of the initially mapped ways and cherry stems from the intensive surveys of the 1980s was compared to present day WSA route locations and conditions. If new trespass routes were found entering into the WSAs, then the routes were identified, measured, recorded, and photographed for future reference.

Routes into each of the six WSAs were resurveyed using a GPS in capturing and mapping route data. A data point was taken at each of the route monitoring test spots along the route as well as photographs and route disturbance measurements. The photographs that were taken at the monitoring points along the ways and cherry stems are used as a visual reference for comparing changes in route conditions and vegetation over time. Data was then entered into GIS attribute tables that were created for comparison with the initial inventoried routes from 1980, routes to current conditions and for future monitoring. The research methods discussed in this chapter include population and sample, data collection protocol, and data analysis.

Population and Sample

The population of this study included all routes into six Wilderness Study Areas in the Tuscarora Filed Office. Random samples from the routes in the six WSAs in Tuscarora Field Office were used for this study. Collection of substantive data for this project was based on the methods used by Howard Wilshire (1977; 2000). The data for this research was gathered in the field on all routes, ways, and vehicle travel into the WSAs whether previously identified in inventories or WSA monitoring reports. Excluded from the sampling frame were the WSA's boundary roads and cherry stems because they are considered to be external to the WSAs.

Data Collection Protocol

To prepare for travel to and data collection in the WSAs each of BLMs four Great Basin Institute (GBI) interns read through the history of each WSA from the 1980, initial intensive inventory file. They focused on maps and previous monitoring of routes in Cedar Ridge, Red Springs, Little Humboldt River, Owyhee Canyon, South Fork Owyhee River, and Rough Hills WSAs before going into the field to gather data. Data for the purpose of this study was track depths, photographs of the route conditions which included vegetation, and recording measurements (See Appendix F, Figure 2) of compaction in previously inventoried routes and new trespass routes in the WSAs.

Maps for each of the WSAs were made from current route data in CITRIX for use in the field as a way to find previously inventoried routes splitting off of the boundary roads and into the WSAs. Wilshire (2000) describes several methods for collecting route data on soil loss, erosion rate, compaction, and displacement of which were used in this study. After in-house familiarization with the WSAs at least two interns traveled to the WSAs to gather and record data. Starting off by driving the boundary roads then when a route forked into a WSA, the interns would determine if it was a route already on the current WSA inventory map or a trespass route. In either case a GPS point was recorded at the edge of the boundary road to mark the beginning of a route into the WSA. While standing in the same spot a photograph of the route heading up (into) the WSA was taken. Then taking a compass reading recorded the direction of the photograph and recorded this on a WSA Route Inventories sheet (See Appendix F, Figure 2). Next a random starting point between 30 and 100 feet was selected to get far enough away from the boundary road to mark the first monitoring point which was measured from the point taken at the edge of the boundary road.

Wilshire describes several methods for collecting data on soil loss, erosion rate, compaction, and displacement (2000). For the purposes of this study as described by Wilshire, compaction/displacement measurements were taken at each of the four random monitoring points along the routes. Equipment used to measure soil compaction/displacement were two 12-inch rebar spikes; 30 feet or so of cord that wouldn't stretch (the cord was marked with a black magic marker at regular 6 inch intervals); a 16-foot locking tape measure; and a hammer.

To measure the amount of soil compaction/displacement in routes required driving the spikes into the ground on both sides of the OHV route so that the cord could be placed next to the natural ground surface height on both sides of the route. Then pulling the cord tight it was tied off at one of the 6-inch increments. Next using the tape measure took readings across the width of the track from the cord down to the ground and recorded them across the whole track at the 6-inch increments and recorded the measurements on the WSA Route Inventories sheet. The track shape was also recorded and described as flat on the bottom, U-shaped, or some other shape.

In the center of the route while straddling the measurement cord a GPS data point is recorded. Next a set of photographs were taken with one photo facing up into the WSA, one photo taken back (down) toward the boundary road, one taken at approximately 90 degrees to the left and right across the monitoring point. A compass heading was recorded for each direction that the photos were taken at each monitoring point and entered on the WSA Route Inventories sheet. Each route had length measurements recorded for at least four route monitoring points with their four photographs for use in future studies and WSA monitoring.

The photographs and GPS reading were brought back to the office and downloaded into CITRIX and the district filing system. The District's GIS Specialist took the data and checked it for correctness and entered it into the WSA corporate data file on CITRIX.

Data Analysis

Data collected was used to develop a set of GIS maps and photos that will be used to compare historic data records to the present findings of this project. This provides the Tuscarora FO with new data to enable a visual representation of routes and their impact distributions on WSAs. This is of particular interest in terms of (a) off road trespass impacts since the WSAs were established, and (b) amount of erosion and/or vegetation found occurring in routes in the six study WSAs in the TFO.

Descriptive statistics are used to characterize the data collected in answering the study questions of:

1. What is the current soil and vegetation condition of previously identified OHV routes in Tuscarora Field Office's six Wilderness Study Areas?

2. What is the current soil and vegetation condition of new trespass routes and/or previously undocumented OHV routes in Tuscarora Field Office's six Wilderness Study Areas?
3. To what extent if any have the route's characteristics changed since being documented in the initial intensive inventory of Wilderness Study Areas?

Data recorded on the WSA Route Inventories sheets were entered into Excel spreadsheets for use in providing a graph of the depth measurements at each point and for calculating the amount of soil compaction/displacement of each route (see Appendices B - E).

To determine the amount of soil compaction in the OHV routes Wilshire (2000) states, "the area, in square inches is usually converted to square feet and multiplied by 5,280 to get cubic feet of soil displaced per mile" (p. 10). The amount of soil compacted/displaced per route in each WSA was added to the attribute table in CITRIX. Priority variables that were recorded at the data points with a GPS and camera are:

1. Vegetation cover
2. Disturbance
3. Compaction
4. Latitude and longitude (GPS data point)

These priority variables were added to the GIS attribute table for each of the six WSAs and the narrative and photographs of the measurement points were added to the WSA case files as part of the administrative records for use in making management decisions and future monitoring of route soil conditions over time.

The same protocol was used with trespass routes found leading into the WSAs. Information collected on these trespasses was the length of the route, data monitoring points, photos of the data points as well as recording track depths. This information was loaded in CITRIX and added to the administration case file for the WSA.

Project Deliverables

One of them is this report documenting the route conditions in six Wilderness Study Areas in Tuscarora Field Office which can be used in the future to compare route improvement or degradation, the amount of soil compaction/displacement, and vegetation in the immediate vicinity of each data point. A case file was built for each WSA and placed in the administrative record. Additionally, the Wilderness Study Area attribute tables in CITRIX were updated and enhanced under the direction of Zachary Pratt, Outdoor Recreation Planner and Bruce Piper Elko District’s GIS Lead to include the route inventory data collected. The updating of CITRIX allows for analysis of the study data and flexibility on the part of the BLM/NLCS in both use and management of these six WSAs over time.

Chapter IV

Analysis & Results

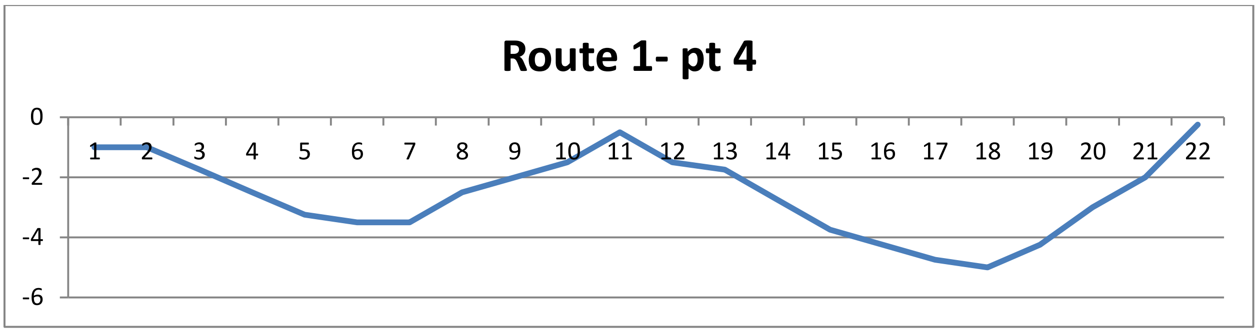
Three questions guided this research: (a) what is the current soil and vegetation condition of previously identified OHV routes in TFO's six Wilderness Study Areas? (b) what is the current soil and vegetation condition of new trespass routes and/or previously undocumented OHV routes in TFO's six Wilderness Study Areas? (c) to what extent if any have the route's characteristics changed since being documented in the initial intensive inventory of Wilderness Study Areas?

To answer these three questions a large number of measurements and photos were taken at each WSA. In addition to this report the data has been entered into CITRIX and folders have been put together with the WSA Route Inventory sheets, photos, and vegetation descriptions. They are located in Elko District's central filing system with the initial inventory data so that it may be used in the future for comparison of route condition and vegetation changes over time.

This chapter presents the analysis and results stated in descriptive form for route length, soil compaction, and vegetation. Maps of initial inventory routes in the WSAs and maps of the current routes (See Appendix A), as well as photographs of each data point with a track depth graph, and descriptions of vegetation located in the vicinity of the data point (See Appendices B – E). A short description is provided here for each WSA taken from the original inventory, followed by the current condition of each WSA followed by answers to the study questions.

As previously stated the photos, compass headings, and track depth measurements were recorded on the WSA route inventories sheet which was then entered into Excel spreadsheets for calculating the track depths and amount of soil compaction from which line graphs were constructed to show the track shape of each route data point. For example a line graph developed from track depth measurements taken at Cedar Ridge WSA Route 1, point 4 is shown in Figure 1. This same technique to graphically display the depth measurements is used for all of the routes, as well as calculations, vegetation descriptions, and photos. Then an approximate amount of soil displaced in cubic yards and tons of soil displaced over the length of the routes was calculated for each WSA (See Appendices B – E).

Figure 1. Cedar Ridge WSA route 1- point 4.



To arrive at the cubic yards and tons of soil displaced the length of the route in miles was converted to inches and multiplied by the width of the route in inches. That product was multiplied by the average depth of displacement for that point, which resulted in the approximate cubic inches of soil displaced. This number was divided by 1728 to convert cubic inches to cubic feet. The cubic feet calculation was then divided by 27 to convert cubic feet to cubic yards. This process was repeated for each of the four points taken within a route. The average amount of cubic yards displaced for that route was calculated by adding all the route's cubic yard calculations and dividing by how many points were taken along the route. To calculate the tons of soil displaced, the total cubic yards of displaced soil was converted to tons by multiplying by 1.35. Since, the soil density of each route was unknown 1.35 was selected from the State of Washington Department of Ecology information for the density of earth/soil, limestone, and sand (dry & loose) because it was assumed that each of the measured routes were composed of these soil types. This is not an accurate survey in representing calculations, so a conservative approach is used to represent significant figures i.e., present 300.5 tons as 300 tons.

Cedar Ridge WSA

Cedar Ridge is located in the southwestern corner of the Elko County Nevada at elevations of 5,613 feet at the extreme southeast corner to 7,149 feet on top of Hilton Peak at the northern boundary. It is comprised of 10,009 acres of BLM managed public land. A dirt road over Hilton Peak forms the north boundary; a fence line road forms the east boundary; the New Corral Road forms the south boundary; and the Sleeman Well road forms the west boundary. It was found in the initial inventory that this WSA contained no surface waters or riparian areas but consisted of juniper and sagebrush plant communities.

Currently, the boundary roads are easily accessed using a truck and were recorded with a GPS. In Cedar Ridge WSA and in the following sections, the routes on which soil displacement data was taken are named/numbered in the order they were inventoried; the first inventoried being Route 1, the second Route 2, and so on.

Route 2, 6, and 7 had been previously recorded in the 2002 Route Inventory Map (See Figures 2 & 3, Appendix A); however, Route 2 was considerably shorter than it had been when measured in 2002, and Route 7 was longer. Route 1 is still a cherry stem route. Three of these routes, 3, 4, and 5 are new trespasses. Two other new trespasses routes were recorded in the GPS but no soil displacement data was recorded on them because the ground was so hard when the trespass took place that only the grass was crushed so there was no track depth to measure. Three routes that had been previously inventoried in Figure 3 are now nonexistent. A total of 5.27 miles of routes were inventoried in Cedar Ridge WSA as shown in Figure 2 and from the depth measurements, the amount of soil displaced is shown in Table 1.

Table 1. Cedar Ridge WSA approximate amount of soil displacement in cubic yards and tons.

Cedar Ridge	*cubic yards of soil displaced*	*tons of soil displaced**
Route 1	5,792	7,819
Route 2	110	149
Route 3	69	94
Route 4	82	110
Route 5	15	20
Route 6	276	373
Route 7	563	761
Total Displacement	6,907 yrds^3	9,236 tons

Note: Tons = soil density multiplier factor 1.35 X cubic yards of soil displaced.

Cedar Ridge route 1 appears to be heavily traveled on alkali soil. The photos show that the route center line had vegetation patterns similar in composition and density as the surrounding vegetation. It is assumed that the vegetation in the center of the route is shorter due to being caught on vehicles traveling over. The tracks were u-shaped with the deepest being 5.75”. Vegetation along route contained Wyoming big sage, rabbitbrush, and native bunch grass. The sagebrush and bunch grass is being encroached on by pinyon pine and juniper.

Route 2 appears to be used more by cattle than vehicles. Vegetation patterns in the route are similar in composition and density as the surrounding vegetation. The tracks are u-shaped on the north side and flat on the south side due to cattle passage with the deepest track being 5.25”. Vegetation consists of sage brush and rabbit brush communities with little or no herbaceous understory. Encroachment by a pinyon-juniper woodland transition with no trees visible at point one to completely developed by point four. Tumble mustard and cheatgrass skeletons can be seen caught in the fence line and has white rabbitbrush near the fence. It appears that the cattle traveling along the route are going to be the cause of the route not being able to restore itself naturally.

Route 3 appears to be recently made, possibly for wood cutting. Before it burned, based on the visible stubble it appears to have been a sagebrush community with some sagebrush reestablishing but currently grassland with natural bunchgrass. Reseeded with basin wild rye, Sandberg bluegrass and crested wheat also seen are non-native western salsify, Mexican whorled, milkweed, and cheatgrass at point 4 and 5. Tracks are shallow and flat with deepest track measuring 3.75”

Route 4 appears to be similar in vegetation community and density to route 3. It is in a wildfire area rehabilitation where juniper has been replaced by bunchgrasses. Sage, cheatgrass, and rabbitbrush are revitalizing the area. Tracks are shallow and flat with route probably made for woodcutting, the deepest point in tracks being 3.75”.

Route 5 is a pinyon-juniper dominated area where most of the grass understory has been crowded out. Big and mountain sage dominate the understory with a small scattering of cheatgrass and tumble mustard. Tracks and terrain are flat with no sign of erosion and maximum track depth is 2.25”.

Route 6 vegetation is a mix of sagebrush and rabbitbrush and appears to be part of a fire line. Pinyon juniper dominates the area except for some areas along the route with the rehabilitation side having basin wild rye, Sandberg bluegrass, and rabbitbrush. Tracks appear to be maintained by cattle movement and range from deep u-shaped to flat with the deepest point being 7.75”.

Route 7 vegetation dominate is big sage with pinyon juniper dominate in higher elevations. There is little evidence of understory with a few pockets of big sage, Sandberg bluegrass. Tracks are u-shaped and flat with cattle appearing to be major user of route with no evidence of erosion. Maximum track depth measured is 9.75".

Red Spring WSA

Red Spring is located in the southwestern corner of the Elko County Nevada at elevations varying between 5,500 to 6,400 feet. It is comprised of 7,847 acres of BLM managed public land. The northern and eastern boundaries are alternating one mile long sections of private property that form zigzag patterned boundary lines; the Indian Well to Huntington Creek road forms the southern boundary; and the Twin Bridges to Indian Well Creek road forms the western boundary. The initial inventory finds this WSA contains a single developed spring just inside the northern boundary and contains densely populated Pinion Pine and Juniper woodland.

The boundary roads were all easily accessed with a truck and UTV and were recorded with a GPS. Five routes that had been previously noted in the 2002, Route Inventory Map (See Figures 4 & 5, Appendix A) are now nonexistent. Soil displacement data was collected on routes 8 and 9, which were both new trespass routes. A total of 1.54 miles were inventoried not including the boundary roads, see Table 2 and Appendix B for soil displacement amounts, photos, track graphs, and vegetation descriptions.

Table 2. Red Spring WSA approximate amount of soil displacement in cubic yards and tons.

Red Spring	*cubic yards of soil displaced*	*tons of soil displaced*
Route 8	568	766
Route 9	257	347
Total Displacement	825 yrds^3	1,113 tons

Note: Tons = soil density multiplier factor 1.35 X cubic yards of soil displaced.

Red Spring route 8 has a combination of u-shape and flat tracks because cattle are walking on one side of the route it keeps the track relatively flat and vegetation free. Vegetation along the route consists of sagebrush, rabbitbrush, and bunchgrass communities. The area along the route has had what appears to be a recent sagebrush die off. Where there is understory along the route it consists of basin wildrye, saltgrass, and cheatgrass. Maximum track depth is 8.75”.

Route 9 transitions from a former sagebrush community to a pinyon juniper forest with no noticeable understory present and then transitions from a juniper pinyon forest back to sagebrush along the route. Where vegetation transitions back to big sage it has a strong bunchgrass understory which consists of basin wildrye, Sandberg bluegrass, and western wheat. Tracks are u-shaped and evident that cattle are using one of the tracks keeping it void of vegetation. Deepest point in the tracks is 14.5”

Rough Hills WSA

Rough Hills is located in the northern section of the Elko County Nevada at elevations of 5,870 to 7,923. It is comprised of 6,685 acres of BLM public lands with 200 acres of private inholdings not included in the WSA acreage. The Humboldt National Forest forms the majority of the northern boundary; the Charleston to Deer Creek Forest Service road from Copper Creek north to the forest boundary, form the northeastern boundary; fenced private property forms the eastern and western boundaries; private lands and fence lines form most of the southern boundary; and a couple hundred feet of Annie Creek Road form the southwestern corner boundary. The initial inventory finds this WSA contains numerous springs, creeks, and over two miles of the Bruneau River. The area contains diverse vegetation including sagebrush, meadow, bitterbrush, serviceberry and other shrub communities along with isolated pockets of aspen and dense strands of mahogany.

This WSA had few boundary roads, most of the boundaries are natural, and access to much of the boundary was extremely difficult. The few access roads that led to the WSA went through private land that was locked, while others access routes were impassible due to eroded road conditions. There is one previously noted route through the southwest most corner of the WSA that could not be reached to collect soil displacement data. Soil displacement data was collected only on route10, which was a new trespass (See Figures 6 & 7, Appendix A). Two other trespasses were recorded by GPS but no soil displacement data was recorded on them because it was a case of crushed vegetation but no track depth. They were not given a route number but instead were named Trespass 1 and Trespass 2. Entry to Rough Hills WSA should be done by helicopter. A total of 0.17 miles were inventoried not including the boundary roads, see Table 3 for tons of soil displaced from route.

Table 3. *Rough Hills WSA soil displacement in cubic yards and tons.*

Rough Hills	*cubic yards of soil displaced*	*tons of soil displaced*
Route 10	33	45
Total Displacement	33 yrds^3	45 tons

Note: Tons = soil density multiplier factor 1.35 X cubic yards of soil displaced.

Rough Hills route 10 appears to have been recently burned with vegetation consisting of great basin wildrye, and rabbitbrush with very thin rocky soils on the surface. In the distance an aspen stand is seen probably because of a spring or snow pocket. Mountain mahogany, snowberry, and bitterbrush communities are visible along the route. Tracks are flat and disappear by last data point on the route with the deepest measuring 4.5”.

Little Humboldt River WSA

Little Humboldt River is located in the far western side of Elko County Nevada at elevations ranging from 5,079 to 7,722 feet. It is comprised of 42,213 acres of BLM managed public land with 480 acres of private inholdings, which is not included in the WSA acreage. A dirt road forms the northern boundary and the eastern boundary; the southern boundary and southwestern boundary are made of alternating private and public land segments that form zigzag patterns where intermittent sections of dirt road also serve as the boundary; and a dirt road forms the northwestern boundary. Identified in the initial inventory this WSA contains at least three rivers and hosts many vegetation communities such as sagebrush and grassland and dense strands of willow, aspen, and wild rose.

The boundary roads were all easily accessed with a truck or UTV and routes were recorded using a GPS. Soil displacement data was collected on five routes, 11, 12, 13, 14, and 15, which were all previously recorded on the 2002, Route Inventory Map (See Figures 8 & 9, Appendix A); however, route 13 and 15 were once a continuous route cutting across the WSA, but now it has reclaimed itself in the middle and it forms two separate routes that do not converge. A cherry stem road and a way on the western boundary have disappeared and three previously recorded trespass routes have vanished as well. A total of 16.51 miles were inventoried, not including the boundary roads, see Table 4, for soil displacement totals.

Table 4. *Little Humboldt River WSA soil displacement in cubic yards and tons.*

Little Humboldt River	*cubic yards of soil displaced*	*tons of soil Displaced*
Route 11	2,066	2,790
Route 12	1,144	1,545
Route 13	322	435
Route 14	895	1,209
Route 15	596	804
Total Soil Displacement	5,023 yrds^3	6,783 tons

Note: Tons = soil density multiplier factor 1.35 X cubic yards of soil displaced.

Little Humboldt River route 11 passes through a fire rehabilitation area and starts with a sage dominant area with an understory of bluebunch, Sandberg bluegrass, and a scattering of cheatgrass. There is evidence that heavy trampling has taken place in the rehabilitation area which is composed of bluebunch, Sandberg bluegrass, basin wildrye, crested wheat, and some cheatgrass. By the end of the route the vegetation community has turned to grassland dominated by bluebunch and Sandberg bluegrass with some rabbitbrush.

Cheatgrass is the dominant understory with tumble mustards visible as the way ends. The tracks are u-shaped and multiple cattle or wild horse paths intertwine with the ways. The three tracks that appear along the way at first were thought to be created by OHVs, but the surface of the flat track path and from the meandering; it is assumed that cattle or wild horses created the tracks (See Photos, Appendix D). The maximum track depth is 6.25”

Route 12 is in a fire rehabilitation area for its entire distance. Vegetation mix along the route consist of forbes (lupines), black or low sage, rabbitbrush, with bluebunch, Sandberg bluegrass, squirreltail, basin wildrye, with small pockets of cheatgrass. The tracks were flat with lots of horse hoof prints and scat in the tracks and the route has a maximum depth of 4.75”.

Route 13 starts out in a shrub and grassland fire rehabilitation area with big sage, Sandberg bluegrass, basin wildrye, and cheatgrass. As the route continues into open grassland dominated by bunchgrasses such as basin wildrye, western wheat, bluebunch, and Sandberg bluegrass although the understory is very hard to identify and it appears that younger big sage plants seem to be recovering from a fire. Maximum track depth is 3.25”.

Route 14 has fire rehabilitation beside and across the route as it travels into the WSA. Vegetation starts out along the route consisting of big sage, basin wildrye, Sandberg bluegrass, rabbitbrush and some cheatgrass and transitions into low mountain sage with some forage kochia, Sandberg bluegrass, and squirreltail. At point three and four multiple tracks can be seen that appear to be made by OHVs but on close inspection they are animal paths that meander back and forth across the route. At times it becomes confusing as to which tracks to drive in and at times our UTV wheels didn’t match any of the tracks which were both flat and u-shaped with the maximum depth of 4.75”.

Route 15 travels through a sagebrush dominated landscape consisting of big sage, black sage, and low mountain sage. Bunch grasses are found on southern facing slopes and include forage kochia, basin wildrye, bluebunch wheatgrass, and Sandberg bluegrass with willows in riparian areas. Tracks were flat overall with lots of animal paths meandering along beside and across the route with the maximum depth measured at 5.75”.

Owyhee Canyon WSA

Owyhee Canyon is located in the northwestern corner of Elko County Nevada at elevations ranging from 4,780 to 5,338 feet. It is comprised of 21,875 acres of BLM managed public lands with 280 acres of private inholdings. A gas pipeline forms the northern boundary and separated the Owyhee Canyon WSA from the South Fork Owyhee River WSA; a dirt road forms the eastern boundary; a stair step form of private land forms the southeastern boundary and the rest of the southern boundary is formed by a dirt road; and a dirt road also forms the entire western boundary. The initial inventory finds this WSA contains the South Fork Owyhee River and offers riparian areas that consist of narrow bands of lush grasses, rushes, and sedges. Vegetation consists of sagebrush, bitterbrush, and bunchgrass communities.

The boundary roads were easily accessed with a truck or UTV and recorded by GPS. No soil compaction/displacement was collected on any routes in this WSA. However, one new trespass was recorded and labeled Trespass 7. Three trespass routes that were previously recorded in the Owyhee Canyon Inventory Map from 2002, (See Figure 12, Appendix A) were recorded and labeled Trespass 5, 6, and 8. Trespass 5 is now longer and trespasses 6 and 8 which had been connected when monitored in 2002, across some private inholding, are not connected through the private land and are two separate shorter routes. One route that had been previously noted in the 2002, Route Inventory Map are now nonexistent.

South Fork Owyhee River

South Fork Owyhee River is located in Owyhee County Idaho and Elko County Nevada at elevations of 5,322 to 4,590 feet in Nevada. It is comprised of a total of 51, 632 acres of Federal land; 43,790 acres of BLM managed public lands in Idaho surrounding one 160 acre privately owned inholding, and 7,842 acres of BLM managed public land in Nevada. For the purpose of this study only the section of the WSA that is within the Elko District was inventoried and the following information is based on only that section. The Idaho State border forms the northern boundary; a dirt road forms the eastern boundary; a gas pipeline forms a section of the southern boundary and separated the South Fork Owyhee River WSA from the Owyhee Canyon WSA; and dirt roads also form the western boundary. The South Fork Owyhee River flows through the length of the WSA. The riparian area consists of narrow bands of lush grasses, rushes, and sedges and on the uplands contains sagebrush, bitterbrush, and bunchgrass communities.

The boundary roads were easily accessed with a truck or UTV and recorded by GPS. No soil compaction/displacement data was taken on any routes in this WSA, but one new trespass was recorded and labeled Trespass 3, and a previously noted trespass labeled 4, was recorded and found to be longer now than in 2002 Route Inventory Map (See Figure 10, Appendix A).

Total Amount of Soil Displaced

Table 5 gives an approximate amount of soil displaced in each of the WSA's that had track depth data collected.

Table 5. Total WSA soil displacement in cubic yards and tons

WSAs	*total cubic yards of soil displaced*	*total tons of soil displaced*	*Tons per mile of soil displaced*
Cedar Ridge	6,907	9,326	1,770
Red Spring	761	1,026	666
Rough Hills	33	45	265
Little Humboldt	5,023	6,783	411
Total Displacement	12,724 yrds^3	17,180 tons	

Note: Tons = soil density multiplier factor 1.35 X cubic yards of soil displaced.

All off road trespasses identified during this study in the WSAs were documented (with GPS point/line and photos) and carsonite signs were placed in the center of the trespass route to indicate it is a closed route and no motorized vehicles are allowed beyond this point.

Chapter V

Discussion and Recommendations

Three questions guided this research: (a) to gather data on the current soil and vegetation condition of previously identified OHV routes, (b) to document the extent, if any, that the route's characteristics changed since being documented in the initial intensive inventory, and (c) to gather and document the current soil and vegetation condition of trespass routes and/or previously undocumented OHV routes in the Tuscarora Field Office's six Wilderness Study Areas.

Photos taken at each data point along routes in Tuscarora Field Office's WSAs were provided; a four-directional view of the routes, the vegetation in the route, and the natural area next to it. This information can be found in CITRIX and folders created for this study will be placed in the District's central filing system as well as in electronic form on the District Filing System (DFS) under TFO, non-renewables, recreation, wilderness and then in folders for each of the WSAs. They will include all of the hand written field notes, photos, maps, and calculations used in writing this report.

Discussion

Since much of the data that was gathered as part of this study had not been collected in the initial intensive inventory, the only characteristic we had to compare was route existence and lengths. Our findings indicate that in each of the six Wilderness Study Areas routes entering them (from the boundary roads) had disappeared. It was also found that a few new trespasses were found entering the WSAs and where that occurred a carsonite marker post was planted in the middle of the tracks on the boundary road. The evidence of previous trespass tracks were raked out. It had been assumed that where the routes have disappeared, the absence occurred through natural revegetation. Revegetation seems to be the case in most incidences, however, remnants of burnt sagebrush and pinyon-juniper stubble with bunchgrasses growing along and across the route would tend to indicate that some wildfire rehabilitation intervention had occurred.

Current route and vegetation information occurring along new trespass routes were gathered and entered into CITRIX our central filing system in the same manner the existing route data is stored. Having this information documented will help management compare positive or negative changes that result from future situations in these WSAs. Resolving conflicts relating to proper vehicle use in and around WSAs and/or types of reseeding effort after a wildfire or drought will also benefit from the study.

For Rough Hills, WSA access to the area is for all purposes impossible at this time. The routes leading up to the WSA have become so washed out and eroded that a truck or UTV cannot get to the unit. Entrance through private land this year was impossible due to locked gates. It appears fixed-wing planes or helicopters will be the best way to check route conditions for trespass in Rough Hills. With the photos, track depth measurements, and vegetation descriptions on routes in these six WSAs now recorded and available, any future route management and/or vegetation rehabilitation will be enhanced. For example, if additional management action needs to be taken to stop vehicle trespass or soil erosion in the routes Elko District Mangers can use the data as a baseline for comparison of route locations, track depth, and vegetation to support their decisions.

Part of this study was to identify routes that had evidence of erosion; however there was very little evidence of soil erosion taking place along the routes in vehicle tracks. This may be an effect of the soil type and/or a desert effect due lack of rain and snow in Elko County. It was observed in watching vehicles, cattle, and wild horses travel on the routes that dust was created and the wind carried the soil away to the surrounding natural environment.

The distances to the WSAs are at least a four-hour drive from the major urban centers of Salt Lake City, Boise, and Reno. The Little Humboldt River, Owyhee Canyon, South Fork Owyhee River, and Rough Hills are a three and a half hour drive from Elko. The travel distance to get to these WSAs might explain why more trespass routes are not being found going into the WSAs and why some of the initial inventory routes have re-vegetated and disappeared. It may also be that the public is getting more educated about WSAs and their uses.

In the Little Humboldt River, WSA cattle and wild horse tracks were as prevalent as OHV tracks. Where animals were obviously using the route as a path, they created ruts greater than the OHV tracks. When driving the routes going into the WSA, at times it was hard to distinguish vehicle tracks from animal, especially when animals' paths meandered along the routes. In photos of what appears to be a two-track route up a hill, (See Appendix H), it is found on closer inspection that there were no vehicle tread marks in the tracks or compaction of the soils in the tracks. Even though the grass is clearly knocked over at the approximate width of a vehicle on close inspection all that can be found in the tracks are animal hoof prints. It is assumed that an OHV made the tracks when the ground was frozen knocking over the grass then as seen so often on other routes either cows, wild horses, or antelope travel in the tracks. This might fool the next OHV user traveling up a non-legitimate route incorrectly thinking they are on an established way.

Carsonite sign posts with wilderness study area stickers were placed in the center of the trespass routes in an attempt to educate and stop the potential trespasser from traveling any further along unauthorized routes. Trespass tracks leading into WSAs were raked out in hopes that others wouldn't follow in the trespass route. The carsonite sign stated they were in a WSA and vehicle travel is not allowed on unauthorized routes. Even with the large number of OHVs in Elko County and the surrounding area, generally OHV enthusiasts are following WSA guidelines for motorized vehicle use in Tuscarora Field Office's six Wilderness Study Areas as of this study.

It was estimated that 12,734 cubic yards or 17,180 tons of soil were displaced as a result of all the track depressions in the six WSAs in Tuscarora's Field Office. If the vehicle tracks in all of the routes in the WSAs were to be filled with soil up to the natural soil depth around them it would take approximately 1,720 loads of soil, in a standard dual-axel ten ton dump truck, to level them out. This is approximately enough soil to cover 16 acres with six inches of dirt.

Recommendations

This study can be used as base-line data for a longitudinal study over the next thirty-years (at five-year increments) on Tuscarora Field Office's WSAs. Since we now have depth, length, vegetation data, and photos along all routes going into these WSAs we can compare changes that occur in and along the routes at the same data points entered in CITRIX and stored in the central filing system. This will contribute to the paucity of information relating to routes in WSAs in Elko District, as well as data on routes in arid and semi-arid areas when human and/or natural disasters occur along one of these routes. If, for example, a wildfire burns across these routes the most current (less than five-years) plant size and mixes would be know when preparing a rehabilitation seed mix. If a WSA becomes a party site, or intensifies in use as a dispersed recreation area, and vehicle travel increases as a result causing more trespass routes and/or deeper tracks in the established ways within a WSA, management can use the data for justifying methods of route closure and reclamation.

A similar study should be conducted of all WSAs in Elko District, recording the characteristics of WSA routes, as well as, including a method for measuring the soil compaction with a hand-held penetrometer. It is also interesting to note that at the end of the routes, that weren't cherry stems, had very limited evidence of vehicles turning around. This makes one consider the possibility that not that many vehicles are traveling up the routes, because normally at the end of cherry stems there is a large area amount of bare soil where vehicles turn around. It would be interesting to know the number of vehicles that are traveling these internal routes and by installing vehicle counters across them at a couple of locations along each route we could determine the number of OHVs traveling the route. Suggested is the use of at least two vehicle counters because it is not evident if vehicles travel all the way to the end of the route or if they are turning around at some other point before the end.

It would also be interesting to know the composition of the vegetation growing in ways that have disappeared over time. This could be accomplished using a GPS (loaded with the initial route coordinates), while walking along the ways that have revegetated and taking soil samples and photos documenting vegetation to see if there any common threads related to the revegetation.